Definite conclusions cannot be drawn from this brief examination of precipitation and run-off records. A more thorough study may reveal contradictory results, or again it may give further support to the opinions which seem justified from the analysis of the available data. One thing is conclusive, which is that precipitation and run-off records are extremely valuable if kept consistently and continuously and that more are needed. Run-off records should be kept on all streams where they emerge from the mountains and at other key points along their courses. Meteorological data taken at high altitudes and so distributed as to be representative of large areas are also needed. This study suggests another use for such data.

TURBIDITY AND WATER VAPOR DETERMINATIONS FROM SOLAR RADIATION MEASUREMENTS AT BLUE HILL, AND RELATIONS TO AIR-MASS TYPES

By HERBERT H. KIMBALL, Research Observer

[Harvard University, Blue Hill Meteorological Observatory, Milton, Mass., September 1934]

The solar radiation intensity measurements obtained at Blue Hill during 1933 have already been published—those for January to August, inclusive, in the REVIEW for August 1933; and for later months, in the corresponding issues that followed—as a part of the radiation data that are published for a number of observing stations in the United States. In table 1 of this paper the values of β and w are given as determined by a method previously described by Kimball and Hand,[1] except that the curves given in the Smithsonian Meteorological Tables, 1931, figure 1, p. LXXXIV, and showing the percentage of depletion of solar radiation by different amounts of atmospheric water vapor, have been drawn separately on cross-section paper that permits a more open scale, and facilitates interpolation.

The first column of table 1 gives in addition to the date, the air mass, m, corresponding to the solar altitude at the time the measurements were made, or more definitely, at the moment the yellow glass screen was replaced by the red screen. The air masses for p. m. measurements are printed in italics. Each screen is usually in place for from 3 to 4 minutes. During this interval the record for the radiation intensity for the total spectrum must be obtained by interpolation.

Readings of the Smithsonian silver disk pyrheliometer made during this same interval, when divided by the scale reading of the interpolated record, give the value of unit scale on the record in gram calories per minute per square centimeter of surface normal to the intercepted solar rays. This value is also sometimes obtained from readings made just preceding or following the screened readings. An apparent progressive decrease in the sensitivity of the thermopile, as indicated by these comparisons, and especially after the advent of warm weather in 1934, was not understood, until the instrument was taken apart at the Eppley laboratory, when it was found that the space above the receiving surface of the thermopile contained several dead insects. These were removed, and the blackened surface was reconditioned. It is fortunate that frequent comparisons have been obtained between the Smithsonian pyrheliometer and the records obtained from the Eppley thermopile, so that it is possible to eliminate most, but probably not all, of the irregularities in the automatic records. Some of the discrepancies that appear in the values of β derived from these screened radiation intensity records quite probably are attributable to this cause.

Determinations of the turbidity factor, β.—The details of the method of determining this factor have been given in the REVIEW for March 1933, already referred to. During the summer of 1933 the transmission of the glass color filters was redetermined by both the United States Bureau of Standards and the laboratory of the United States Department of Agriculture Bureau of Soils. In both laboratories the transmissions were found to be about 0.992 that given by Feussner's tests,[2] or 0.871 for the transmission of the red filter, RG_2, and 0.882 for the transmission of the yellow filter, OG_1, instead of 0.878 and 0.889, respectively, which had previously been used. Early in 1934, during cold winter weather, the transmissions were again determined at the laboratory of the United States Department of Agriculture, and the values obtained were in close accord with those given by Feussner. The difference in the two determinations at the United States Department of Agriculture laboratory is attributed to the difference in the temperature of the laboratory at the times the tests were made, it being considerably cooler in winter than in summer. What effect may be produced by the high temperatures to which the screens are subjected when exposed to the sun in summer as compared to the low temperatures under similar exposures in winter, is a problem yet to be solved. In the mean time, the values determined during the summer of 1933 are being employed. Too high values for the transmission of the screens increases slightly the differences I_m-I_r, and decreases slightly the differences I_y-I_r. The values of β derived from these differences will be affected in an opposite direction, i. e., slightly lower values for βI_{m-r}, and slightly higher values for βI_{y-r}. A value of β_{mean} that is too low gives a value of $I_{m(w=0)}$ that is too high, resulting in too high a value for $I_{m(w=0)}-I_m$, and, consequently, of w. Therefore, this method of determining the water-vapor content of the atmosphere can hardly be expected to rank in accuracy with spectrobolometric methods.

Mr. H. Wexler of the observatory staff, and also a graduate student in the School of Meteorology, Massachusetts Institute of Technology, has determined from air-mass analysis maps made twice each day at the school, the type of air-mass prevailing in the vicinity of Blue Hill on days when solar radiation intensity measurements were made. The air-mass type is indicated by symbols, the significance of which is as follows:[3]

Symbol	Source
P_A	Colder portions of the North Atlantic.
P_C	Alaska, Canada, and the Arctic.
P_P	North Pacific Ocean.
N_{PA}	Modified North Atlantic.
N_{PC}	P_C modified in southern and central United States.
N_{PP}	P_P modified in western and central United States.
T_G	Gulf of Mexico and Caribbean Sea.
N_{TG}	T_G modified in United States or over North Atlantic Ocean.
T_A	Tropical Atlantic.
N_{TA}	T_A modified in the United States or over the Atlantic Ocean.
N_{TM}	Do
T_P	Tropical Pacific.
N_{TP}	T_P modified in the United States.

[1] Kimball, Herbert H., and Hand, Irving F. The Use of Glass Color Screens in the Study of Atmospheric Depletion of Solar Radiation. MONTHLY WEATHER REVIEW, vol. 61, pp. 80-83, March 1933.

[2] Met. Zeit., 1932, Heft 6, S. 242–244.

[3] For a complete exposition of the significance of the different air-mass types see Willett, H.C., American Air Mass Properties, Papers on Physical Oceanography and Meteorology. Published by Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, vol. 2, no. 2, Cambridge, Mass., June 1933.

Mr. Wexler has also determined from the records obtained during daily airplane flights by the school, the liquid water content of the atmosphere to the heights attained by the plane. The air-mass type, the value of w obtained from airplane records, and the height attained by the plane, are given in the last three columns of table 1.

With reference to the determinations of the moisture content of the atmosphere from records obtained during airplane flights, Mr. Jerome Namias of the school staff, makes the following statement:

It is well known that the hair hygrograph is a particularly sluggish instrument when the temperature is low and the moisture content of the air is small. At temperatures lower than −20° C., the hygrograph will frequently show only the general trend of the changes in relative humidity. In the months from January to April the upper atmosphere over Boston is coldest. Therefore the errors in the measurement of relative humidity are greatest at this period of the year. Under such conditions the general tendency will probably be for the readings at upper levels in the atmosphere to be somewhat higher than the actual values. This statement is based upon the fact that the moisture content is generally highest in the lowest layers, where the temperature is also highest. Therefore, as the airplane climbs, the lag coefficient of the hair increases. Under average conditions the highest flights are made in an anticylone which generally consists of a polar, perhaps transitional polar, air mass. Such air masses are generally free of any appreciable cloudiness, and considerable subsidence is frequently indicated. The effect of this subsidence is, of course, to lower the relative humidities throughout the subsiding air mass. Thus as the plane climbs into this dryer air the hygrograph should show the decrease, but due to the large coefficient of lag at such low temperatures only the general tendency to decreasing values of relative humidity is shown and so the recorded values are too high.

In table 2 are given for each month the mean of the liquid water content of the atmosphere for days on which solar radiation intensity measurements were obtained at Blue Hill, omitting the months June to September, when no airplane flights are made.

TABLE 2.—*Mean liquid water content of the atmosphere*

	From solar radiation measurements		From airplane soundings, liquid water in millimeters
	Number of days	Liquid water in millimeters	
1933			
January	2	3.2	6.7
February	8	3.2	6.2
March	12	3.5	4.7
April	9	6.7	9.2
May	11	16.2	13.6
October	16	12.8	15.8
November	15	9.9	10.0
December	3	13.3	11.0
Averages, May-November		13.0	13.1

While it cannot be claimed that the determinations of the water content of the atmosphere are strictly accurate by either of the above methods, and especially as no correction has been applied to the airplane determinations for the atmospheric water content above the height reached by the plane, they at least show seasonal changes and changes with type of air-mass, as is indicated in the following summary, where midwinter is considered to extend from December 22 to March 21, and midsummer from June 21 to September 22.

It is of interest to note that the lowest value of β is found in P_C air in both summer and winter. Also, the lowest water-vapor content is found with P_C air in winter and with P_A air in summer.

MIDWINTER SEASON

Air mass source	Number of days	Average β mean	Average w (mm.)
P_C	5	0.044	2.0
P_A	1	.039	5.3
N_{PP}	5	.072	4.8

MIDSUMMER SEASON

Air mass source	Number of days	Average β mean	Average w (mm.)
P_C	6	0.043	21.4
P_A	1	.123	8.7
T_M	1	.143	15.0
N_{PA}	2	.085	21.0
N_{PP}	2	.056	10.8

TABLE 1.—*Values of β (atmospheric turbidity factor), and w (atmospheric water vapor content), computed from measurements of the total (I_m) and screened (I_y, I_r) solar radiation intensity, obtained at the Blue Hill Meteorological Observatory of Harvard University*

Date and air mass	$\frac{I_m}{1.94}$	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$I_{w=0}-I_m$	w	Air-mass type	w, in mm., from airplane	Height of ascent, in meters
1933									
Jan. 15:						*mm*			
3.20	51.8	0.050	0.074	0.062	10.4	5.9	N_{PP}	8.1	4,920
Jan. 24:									
3.14	57.7	.063	.100	.082	.8	-----	N_{PP}	5.3	5,300
2.09	71.7	.039	.052	.046	3.2	.6			
Feb. 6:									
2.45	73.0	.015	.022	.018	2.5	.5	P_C	2.3	4,900
Feb. 13:									
2.68	59.2	.048	.084	.066	6.6	2.0	N_{PC}	5.3	5,320
1.84	64.8	.075	.088	.082	5.3	1.7			
Feb. 16:									
3.08	55.4	.051	.080	.066	4.9	1.2	P_C, N_{PC}	3.7	5,230
Feb. 21:									
2.06	63.3	.063	.093	.078	4.6	1.3	N_{PP}	6.1	5,410
Feb. 22:									
1.93	67.2	.055	.053	.054	6.7	2.5	N_{PC}	5.4	5,130
Feb. 23:									
1.62	59.7	.099	.095	.097	10.0	9.0	N_{PP}	12.0	5,110
Feb. 24:									
1.86	59.8	.086	.080	.083	9.4	6.4	N_{PP}	6.1	5,310
2.56	57.1	.070	.078	.074	7.0	2.4	N_{PC}		
Feb. 27:									
1.57	70.2	.042	.026	.034	5.0	1.6	P_A	8.5	5,150
1.90	65.7	.049	.040	.044	10.2	9.0			
Mar. 5:									
1.55	74.6	.027	.067	.047	5.7	2.0	P_C	3.3	4,440
Mar. 6:									
2.72	63.7	.048	.051	.050	4.2	.9	P_C	3.9	5,080
1.76	71.1	.042	.055	.048	6.1	2.1			
1.50	73.1	.040	.062	.051	6.4	2.5			
1.49	73.2	.043	.047	.045	6.9	2.9			
1.57	71.2	.052	.082	.067	4.9	1.5			
Mar. 9:									
2.06	56.0	.096	.070	.083	10.2	8.8	N_{PP}	7.0	5,610
2.65	46.4	.091	.096	.094	11.9	13.8			
Mar. 10:									
2.18	62.1	.060	.065	.062	8.0	3.4	P_C	2.7	4,520
Mar. 11:									
2.31	69.2	.027	.070	.048	4.3	1.1	P_C	2.2	5,340
1.69	71.3	.033	.066	.050	2.7	.6			
1.55	75.3	.027	.031	.029	7.2	3.1			
1.45	75.3	.028	.033	.030	7.7	3.8			
2.08	67.9	.025	.061	.043	6.9	2.6			
Mar. 16:									
2.28	67.0	.036	.054	.045	6.0	1.9	P_C, N_{PC}	4.8	5,240
1.95	71.1	.039	.042	.040	5.7	1.8			
1.61	74.3	.046	.035	.040	5.6	1.9			
1.45	74.5	.054	.055	.054	5.1	1.7			
1.39	76.5	.047	.044	.046	4.4	1.4			
1.45	76.3	.047	.037	.042	4.7	1.5			
1.88	70.3	.052	.028	.040	6.4	2.3			
3.14	58.0	.049	.036	.042	8.9	4.5			
Mar. 17:									
1.38	69.9	.058	.092	.075	7.4	3.6	N_{PP}	10.0	5,050
1.39	66.8	.072	.052	.062	8.8	5.8			
Mar. 24:									
1.60	65.2	.069	-------	.069	9.5	7.3	P_C	4.4	5,240
1.34	73.1	.060	.037	.048	7.9	4.3			
1.32	74.7	.046	.038	.042	7.3	3.6			
1.32	74.0	.057	.046	.052	6.4	2.7			
1.55	69.9	.069	.053	.061	6.1	3.0			
2.24	60.2	.079	.055	.067	7.9	3.3			
Mar. 25:									
1.33	74.0	.055	.079	.067	4.1	1.2	P_C	3.8	5,320
1.31	73.6	.059	.069	.064	5.2	1.6			
Mar. 27:									
1.84	63.4	.064	.088	.076	8.3	4.0	P_A	5.2	5,250
2.51	55.1	.078	.085	.082	7.5	2.8			

TABLE 1.—*Values of β (atmospheric turbidity factor), and w (atmospheric water vapor content), computed from measurements of the total (I_m) and screened (I_y, I_r) solar radiation intensity, obtained at the Blue Hill Meteorological Observatory of Harvard University*—Continued

Date and air mass	$\frac{I_m}{1.94}$	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$I_{w=0}-I_m$	w	Air-mass type	w, in mm., from airplane	Height of ascent, in meters
1933									
Mar. 29:						*mm*			
1.31	64.5	.116	.138	.127	5.5	2.0	P_A	9.4	4,920
Mar. 30:									
1.38	73.5	.052	.046	.049	7.0	3.1	N_{PC}	4.6	5,450
1.28	74.4	.050	------	.050	8.1	3.9			
1.83	68.5	.044	.045	.044	8.6	4.4			
Apr. 5:									
1.67	64.9	.081	.081	.081	7.2	3.0	N_{PC}	8.2	5,400
1.43	70.8	.057	.093	.075	5.9	2.2			
1.27	75.0	.047	.090	.068	3.8	1.1			
1.25	75.0	.048	.098	.073	4.8	1.6			
1.87	66.9	.050	.049	.050	8.3	4.0			
3.31	54.8	.052	.054	.053	8.7	3.3			
Apr. 9:									
1.24	72.8	.053	.034	.044	11.3	20.0	N_{PC}	9.2	5,180
Apr. 10:									
1.43	70.4	.054	.038	.046	10.1	10.0	N_{PC}	10.5	5,300
1.27	71.7	.060	.030	.045	10.6	15.0			
1.24	72.7	.050	.038	.044	10.1	12.0			
Apr. 11:									
1.62	68.5	.059	.032	.046	10.2	9.5	N_{PC}	11.5	5,320
Apr. 20:									
1.18	72.5	.069	.121	.095	3.6	.9	P_A	9.6	5,300
1.17	72.4	.074	.107	.090	5.3	1.7			
Apr. 21:									
1.81	65.5	.062	.093	.078	6.2	2.2	N_{PC}	8.2	5,460
1.73	68.2	.040	.070	.055	7.5	2.4			
1.23	70.8	.065	.140	.102	3.3	.8			
1.17	72.2	.071	.094	.082	5.8	2.0			
Apr. 22:									
1.58	72.1	.039	.078	.058	4.6	1.4	N_{PC}	9.9	4,700
Apr. 24:									
1.92	66.0	.049	.113	.081	3.0	.7	N_{PC}	10.1	6,100
1.19	67.8	.099	.073	.086	9.6	9.6			
1.15	68.9	.098	.123	.110	5.9	2.5			
2.20	49.1	.144	.124	.134	7.6	3.0			
Apr. 28:									
1.42	72.4	.047	.030	.038	10.6	13.0	N_{PC}	5.5	5,500
1.17	73.5	.070	.060	.065	7.3	3.9			
1.13	72.3	.074	.092	.083	6.3	2.8			
May 4:									
1.33	74.8	.039	.028	.034	8.8	6.5	N_{PC}	14.4	5,080
1.17	75.7	.040	.046	.043	8.1	5.0			
1.15	76.8	.031	.048	.040	7.8	4.7			
1.32	72.7	.043	.045	.044	9.1	7.3			
2.76	57.8	.063	.057	.060	7.2	3.0			
May 7:									
1.11	89.6	.019	.010	.014	8.7	7.5	N_{PC}	8.5	5,090
May 9:									
1.11	74.1	.063	.044	.054	8.7	5.0	P_C, T_G aloft	10.1	5,280
1.10	75.8	.052	.052	.052	6.4	3.0			
May 12:									
1.12	63.3	.128	.085	.106	12.6	37.0	N_{PC}, T_G aloft	20.4	5,290
1.74	44.6	.193	.160	.176	12.4	22.0			
May 15:									
1.13	71.2	.059	.062	.060	10.4	16.0	N_{PP}	12.2	5,940
May 16:									
1.45	69.2	.044	.034	.039	12.3	25.0	N_{PC}, T_G aloft	11.0	5,580
May 17:									
1.09	73.7	.053	.062	.058	9.1	9.1	N_{PC}	7.6	5,350
1.09	73.1	.056	.062	.059	9.5	11.0			
May 18:									
1.74	65.1	.064	.050	.057	9.8	10.0	N_{PC}	11.8	5,350
1.16	71.9	.084	.039	.062	9.1	8.3			
1.10	70.6	.086	.067	.076	9.3	9.7			
1.25	68.4	.076	.035	.056	12.6	33.0			
May 19:									
1.64	61.2	.082	.082	.082	10.7	12.0	N_{PA}	14.0	5,910
2.18	46.4	.106	.066	.086	18.1	------			
May 20:									
1.37	75.1	.026	.009	.018	10.9	15.0	T_G	18.0	5,710
May 24:									
1.57	56.6	.100	.098	.099	13.6	36.0	N_{PC}, T_G aloft	22.7	4,860

Date and air mass	$\frac{I_m}{1.94}$	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$I_{w=0}-I_m$	w	Air mass type
1933							
June 2:						*mm*	
1.71	61.4	0.087	0.110	0.098	7.0	3.3	N_{PC}
1.06	77.0	.047	.024	.036	9.0	9.5	
1.18	76.3	.036	.021	.028	9.6	10.0	
1.71	68.6	.044	.034	.039	10.6	11.1	
June 3:							
2.93	51.2	.073	.070	.072	9.4	4.3	N_{PC}
1.27	63.7	.089	.085	.087	12.5	22.0	
1.09	67.6	.082	.089	.086	11.1	21.0	
1.19	64.3	.078	.040	.059	16.5	50.+	
June 4:							
1.22	65.9	.071	.081	.076	11.3	21.0	N_{PP}, N_{TM} aloft.
1.07	75.5	.026	.020	.023	11.2	25.0	
1.32	68.9	.051	.024	.038	14.2	48.0	
June 7:							
1.08	59.4	.146	.143	.144	13.0	42.2	N_{PC}, T_G aloft.

TABLE 1.—*Values of β (atmospheric turbidity factor), and w (atmospheric water vapor content), computed from measurements of the total (I_m) and screened (I_y, I_r) solar radiation intensity, obtained at the Blue Hill Meteorological Observatory of Harvard University*—Continued

Date and air mass	$\frac{I_m}{1.91}$	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$I_{w=0}-I_m$	w	Air mass type
1933							
June 8:						*mm*	
1.23	63.0	.102	.070	.086	13.6	44.0	N_{PC}, T_G aloft.
1.14	62.7	.102	.083	.092	14.6	56.0	
1.07	64.4	.117	.089	.103	12.8	41.0	
1.06	64.4	.088	.074	.081	15.5	------	
June 9:							
1.36	61.3	.098	.078	.088	13.2	20.0	N_{PC}, T_G aloft. T_G
1.11	64.6	.098	.087	.092	13.4	28.0	
1.06	65.6	.088	.071	.080	14.4	47.0	
1.32	53.6	.110	.108	.109	18.5	------	
1.79	50.2	.124	.092	.108	16.0	27.0	
June 10:							
1.12	70.7	.054	.051	.052	12.2	27.0	N_{PC}
2.20	54.3	.072	.078	.075	13.0	17.6	T_G aloft.
June 11:							
2.42	50.3	.073	.085	.079	14.3	24.0	N_{PC}
1.45	64.3	.056	.081	.068	13.1	21.5	
1.13	71.0	.053	.051	.052	11.5	26.0	
1.06	71.9	.057	.064	.060	10.8	18.0	
1.10	71.7	.056	.071	.064	9.8	14.3	
1.40	67.5	.055	.059	.057	10.4	12.0	
1.43	67.2	.055	------	.055	11.1	16.0	
1.71	64.3	.055	.068	.062	10.3	13.0	
3.02	51.5	------	.059	.059	12.0	12.5	
June 12:							
1.06	61.6	.114	.083	.098	16.4	53.0	T_G
June 14:							
2.15	56.9	.077	.077	.077	9.4	5.6	P_C
1.41	64.9	.085	.087	.086	9.0	6.3	
1.17	63.9	.142	.112	.127	8.7	5.4	
June 15:							
2.64	56.2	.067	.056	.062	9.0	4.0	P_C
1.29	70.2	.060	.077	.068	8.3	4.9	
June 18:							
2.88	53.0	.060	.059	.060	10.7	8.0	P_C, N_{PC} aloft.
June 19:							
2.65	44.4	.116	.104	.110	11.6	12.4	P_C
June 20:							
1.07	71.8	.049	.059	.054	11.3	26.0	N_{PC}
1.06	74.6	.057	.067	.062	8.2	6.4	
1.06	72.1	.065	.066	.066	9.6	12.0	
June 22:							
1.19	62.5	.090	.114	.102	11.9	28.0	N_{PP}, N_{PC} aloft.
1.13	64.0	.091	.114	.102	12.2	33.0	
June 23:							
2.84	54.8	.059	.061	.060	9.2	4.1	N_{PP}
1.06	76.4	.041	------	.041	8.7	8.1	
1.08	76.1	.043	.018	.030	10.7	20.0	
1.11	75.6	.049	.062	.056	6.8	3.5	
1.84	64.6	.054	.045	.050	11.0	13.0	
2.99	56.8	.043	.016	.030	15.6	47.0	
June 24:							
2.70	57.8	.054	.039	.046	11.1	10.0	N_{PC}
1.26	65.0	.088	.077	.082	12.0	27.0	
1.06	64.1	.138	.128	.133	9.9	14.6	
1.76	55.4	.113	.128	.120	10.2	9.3	
June 27:							
1.64	51.3	.143	.143	.143	11.2	15.0	T_M
July 12:							
1.07	66.2	.145	.200	.172	3.2	.8	P_A
1.10	68.6	.143	.128	.136	4.1	1.3	
1.17	66.2	.133	.127	.130	6.2	2.9	
1.67	58.7	.089	.081	.085	12.3	22.0	
1.84	55.6	.106	.074	.090	12.7	24.0	
2.62	47.9	.104	.142	.123	5.1	1.3	
July 13:							
1.68	53.5	.155	.104	.130	9.9	8.3	N_{PA}
1.40	62.2	.086	.127	.106	9.1	6.7	
1.14	66.8	.084	.135	.110	8.2	5.5	
1.06	67.9	.099	.112	.106	9.1	9.5	
1.09	64.6	.105	.102	.104	12.0	30.2	
1.20	62.8	.095	.094	.094	13.8	47.0	
1.57	59.2	.085	.069	.077	14.4	46.0	
2.69	52.8	.049	.067	.058	13.4	22.0	
July 14:							
1.52	62.9	.076	.072	.074	11.9	20.0	N_{PA}
1.36	64.0	.084	.080	.082	11.7	21.0	
1.13	68.0	.079	.085	.082	10.6	18.0	
1.07	69.9	.071	.046	.058	11.9	32.0	
1.13	70.2	.076	.079	.078	9.2	9.0	
1.17	69.3	.062	.081	.072	10.8	9.9	
1.67	61.9	.076	.069	.072	11.6	25.0	
2.72	51.2	.072	.065	.068	12.8	26.0	
July 18:							
1.30	67.2	.071	.054	.062	12.3	29.0	N_{PC}
1.20	68.4	.072	.040	.056	13.0	38.6	
1.07	72.7	.046	.008	.027	14.4	57.0	
1.58	64.4	.050	.013	.032	17.2	------	
Aug. 6:							
1.12	76.8	.034	.031	.032	9.2	10.0	P_C
1.19	77.0	.025	------	.025	9.4	9.9	
1.34	73.2	.029	.012	.020	12.6	26.0	
1.53	69.4	.039	.022	.030	13.5	35.5	
Aug. 7:							
1.19	70.9	.049	.032	.040	13.0	39.0	N_{PC}
Aug. 9:							
1.13	72.5	.048	------	.048	10.8	19.3	P_C
1.18	72.3	.048	------	.048	9.2	16.0	
4.22	43.5	.050	.047	.048	15.5	32.0	

TABLE 1.—*Values of β (atmospheric turbidity factor), and w (atmospheric water vapor content), computed from measurements of the total (I_m) and screened (I_y, I_r) solar radiation intensity, obtained at the Blue Hill Meteorological Observatory of Harvard University*—Continued

Date and air mass	$\frac{I_m}{1.94}$	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$I_{w-o}-I_m$	w	Air mass type
1933							
Aug. 11:						*mm*	
1.12	70.6	0.049	0.019	0.034	13.1	43.0	P_C, T_M aloft.
Aug. 26:							
3.10	56.3	.026	.029	.028	14.9	30.5	N_{PC}
3.63	46.3	.040	.025	.032	11.3	11.0	P_A
Aug. 27:							
1.26	56.1	.142	.109	.126	14.9	50	N_{PC}
1.58	58.0	.108	.075	.092	13.2	32.0	
Aug. 30:							
2.02	68.5	.031	.026	.029	10.1	7.7	
1.19	72.8	.046	.056	.051	9.3	14.0	
1.24	72.6	.033	-------	.033	11.8	25.0	P_C
1.63	68.2	.036	.020	.028	13.9	39.0	
2.15	61.5	.042	.032	.037	14.0	46.0	
Sept. 2:							
1.73	59.9	.080	.061	.070	13.1	29.0	
1.65	62.2	.074	.047	.060	13.5	33.0	
1.27	65.9	.081	.053	.067	14.1	43.0	
1.81	63.3	.110	.107	.108	10.2	13.0	P_C
1.71	56.8	.106	.100	.103	11.0	13.0	
3.14	37.8	.114	.083	.098	15.8	50.0	
Sept. 12:							
2.19	68.4	.037	.019	.028	9.2	4.9	
1.73	70.9	.044	.021	.032	9.4	6.3	P_C
1.27	75.4	.041	.030	.036	8.2	4.8	
1.38	72.2	.050	.027	.038	10.4	12.0	
Sept. 13:							
1.34	73.1	.028	.025	.026	11.7	22.0	P_C
Sept. 19:							
2.81	53.8	.064	.065	.064	10.1	4.0	N_{PP}
Sept. 22:							
2.86	55.1	.044	.048	.046	12.6	18.1	P_C N_{PP} aloft.
Sept. 23:							
2.77	60.3	.045	.031	.038	10.3	8.2	P_C N_{PP} aloft.
1.45	73.0	.038	-------	.038	8.7	5.2	
Sept. 30:							
1.74	65.3	.046	.030	.038	13.6	34.0	
1.45	64.4	.077	.051	.064	12.9	31.0	N_{PP}
1.45	66.9	.045	.056	.050	12.2	24.0	
2.02	58.4	.056	-------	.056	14.0	36.0	

Date and air mass	$\frac{I_m}{1.94}$	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$I_{w-o}-I_m$	w	Air-mass type	w, in mm., from airplane	Height of ascent, in meters
1933									
Oct. 2:						*mm*			
1.72	59.8	0.079	0.069	0.074	12.5	23.0	N_{PP}	25.6	4.840
3.11	51.6	.045	.045	.045	14.6	42.0			
Oct. 3:									
1.99	62.4	.075	.075	.075	7.0	2.7			
1.52	69.1	.040	-------	.040	7.4	3.3	N_{PC}	15.9	5.280
1.46	69.6	.041	-------	.041	9.2	6.8			
Oct. 8:									
3.14	66.1	.004	-------	.004	12.5	14.5			
1.57	71.2	.030	.004	.017	13.3	33.0			
1.50	70.6	.023	-------	.023	13.3	35.0	N_{PC}	26.1	5.180
1.89	67.1	.027	.021	.024	13.7	33.0			
2.12	63.5	.033	-------	.033	13.5	29.0			
Oct. 10:									
2.06	61.8	.074	.051	.062	8.2	3.7			
1.61	66.1	.070	-------	.070	8.2	4.1			
1.53	66.4	.077	.054	.066	8.0	4.0	N_{PC}	16.3	5.280
2.26	53.9	.083	.065	.074	12.8	21.0			
Oct. 11:									
2.09	63.7	.056	.045	.050	9.3	5.4	N_{PC}	16.3	5.100
Oct. 12:									
2.13	55.7	.081	.082	.082	13.5	29.0	N_{PC}	23.1	5.180
2.21	46.7	.106	-------	.106	14.3	36.7			
Oct. 14:									
2.16	64.8	.050	.025	.038	8.8	4.3			
1.58	72.4	.025	-------	.025	10.6	12.0			
1.65	71.5	.030	-------	.030	10.1	9.3	P_C	8.5	5,240
2.06	69.4	.028	.029	.028	9.1	4.9			
Oct. 15:									
2.06	66.2	.043	.011	.027	8.3	4.8			
1.58	69.9	.039	.030	.034	11.3	14.0	N_{PC}		
1.72	67.4	.049	.021	.035	13.6	34.1	N_{PP}	14.7	5,180
2.28	61.0	.039	-------	.039	13.0	22.5			
Oct. 16:									
1.67	70.3	.037	-------	.037	7.0	3.2	N_{PC}	15.9	5,370

TABLE 1.—*Values of β (atmospheric turbidity factor), and w (atmospheric water vapor content), computed from measurements of the total (I_m) and screened (I_y, I_r) solar radiation intensity, obtained at the Blue Hill Meteorological Observatory of Harvard University*—Continued

Date and air mass	$\frac{I_m}{1.94}$	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$I_{w-o}-I_m$	w	Air-mass type	w, in mm., from airplane	Height of ascent, in meters
1933									
Oct. 18:						*mm*			
2.15	62.5	0.058	0.043	0.050	9.9	7.2			
1.67	61.8	.084	.067	.076	10.6	11.0	N_{PP}	10.9	5,460
1.62	64.5	.079	.058	.068	10.1	5.7			
Oct. 19:									
2.28	66.7	.039	.031	.035	7.8	4.2			
1.70	71.8	.027	.047	.038	7.6	3.4	N_{PP}	9.8	5,140
1.78	70.4	.040	.024	.032	9.6	7.2			
Oct. 21:									
2.18	64.3	.054	.050	.052	7.7	3.0	P_C	14.8	5,540
Oct. 26:									
2.35	65.7	.043	.022	.032	9.6	5.4			
1.89	70.3	.037	.034	.036	8.8	4.9	P_C	9.3	5,360
1.74	72.1	.042	.037	.040	6.4	2.4			
2.81	61.8	.039	.049	.044	8.2	4.1			
Oct. 29:									
2.38	68.6	.039	-------	.039	4.7	1.2	P_C	11.1	5,270
1.75	69.2	.037	.028	.032	3.8	1.0	N_{PP} aloft.		
Oct. 30:									
2.45	53.0	.088	.088	.088	8.7	3.9	P_C	12.8	5,320
1.90	59.7	.062	.067	.064	12.8	24.0	N_{PP} aloft.		
Oct. 30:									
1.90	46.7	.138	.140	.139	13.2	28.0	N_{PC} N_{PP} aloft.	22.4	4,620
Nov. 1:									
2.40	60.9	.055	.030	.042	11.6	14.0			
1.82	65.1	.045	-------	.045	11.8	12.6			
1.95	65.3	.041	.035	.038	10.4	10.5	N_{PC}	15.2	5,380
2.53	62.4	.034	.020	.027	13.0	20.0			
2.38	59.4	.037	.022	.030	12.8	17.0			
Nov. 2:									
2.41	54.0	.075	.060	.068	12.5	18.0	N_{PC}	18.0	5,310
2.14	55.9	.079	.072	.076	11.6	15.0			
Nov. 5:									
1.88	70.4	.042	-------	.042	6.6	2.4	P_C	5.7	4,080
Nov. 8:									
3.99	48.9	.068	.034	.051	11.7	11.0	P_C N_{PC} aloft	11.0	4,360
Nov. 11:									
2.17	65.7	.047	.040	.044	8.1	3.5	P_C	5.2	5,380
Nov. 12:									
2.00	60.4	.095	.088	.092	5.4	1.7			
2.85	62.3	.049	.040	.044	6.2	2.2	P_C	9.6	4,960
3.10	61.6	.039	.023	.031	8.6	3.4			
Nov. 16:									
2.33	71.5	.036	.027	.032	4.0	.9			
2.06	71.2	.039	.016	.028	7.2	2.8	P_C	1.7	4,850
3.70	58.3	.039	.027	.033	7.9	3.0			
Nov. 19:									
3.57	51.5	.055	.045	.050	10.3	5.0	P_C N_{PP} aloft	5.3	4,680
Nov. 21:									
2.96	63.8	.015	.016	.016	12.8	17.0	P_C N_{PP} aloft	10.5	5,050
Nov. 23:									
2.42	55.6	.068	.060	.064	12.2	17.0	P_C N_{PP} aloft	10.7	4,880
Nov. 25:									
2.33	62.8	.042	.031	.036	11.7	15.0	P_C	9.1	4,740
Nov. 27:									
2.28	54.6	.083	.092	.088	9.4	5.2	N_{PP} aloft.	1.0	2,920
Nov. 28:									
2.84	49.0	.084	.080	.082	10.7	9.2	N_{PP}	7.7	4,870
Nov. 29:									
2.26	60.9	.053	.031	.042	13.1	24.0	N_{PP}	12.3	4,880
Nov. 30:									
2.81	39.7	.143	.147	.145	8.7	3.6	T_G	18.6	5,050
2.27	40.5	.160	.181	.170	10.1	7.8			
Dec. 7:									
2.46	61.2	.054	.054	.054	8.2	3.4	N_{PC}	8.9	4,740
2.41	60.5	.047	.063	.055	8.5	3.7			
Dec. 14:									
2.74	51.2	.070	.065	.068	12.3	15.0	P_C	5.5	4,800
3.97	42.0	.060	.074	.067	12.9	13.0	N_{PC} aloft.		
Dec. 16:									
2.62	56.6	.051	.035	.043	13.6	25.0	N_{PP}	18.7	4,180
3.65	45.4	.057	.055	.056	14.1	22.0			
Dec. 28:									
3.36	50.1	.062	.057	.060	7.3	2.0	N_{PC}	-------	-------